This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Eng
1108.842

GODFREY LOWELL CABOT SCIENCE LIBRARY
of the Harvard College Library

This book is
FRAGILE
and circulates only with permission.
Please handle with care
and consult a staff member
before photocopying.

Thanks for your help in preserving
Harvard's library collections.

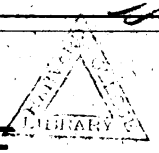
Digitized by Google

E

GOD

Digitized by Google

F.1472 Conn



SANITARY DRAINAGE

OF

TENEMENT-HOUSES.

BY

WM. PAUL GERHARD, C.E.,

NEW YORK CITY.

[*From the Report of the Secretary of the Connecticut Board of Health*, 1883.]

HARTFORD, CONN.:
THE CASE, LOCKWOOD & BRAINARD CO., PRINTERS.
1884.

Digitized by Google

Digitized by Google

COMPLIMENTS OF

WM. PAUL GERHARD,

CIVIL AND SANITARY ENGINEER,

NEW YORK CITY,

127 EAST 86TH STREET.

PLEASE ACKNOWLEDGE RECEIPT OF REPORT OR SEND COPY OF PAPER, CONTAINING A REVIEW.

Sanitary Drainage of Tenement Houses.

By WM. PAUL GERHARD, C.E.,

NEW YORK CITY.

[From the Proceedings of the State Board of Health.]

Digitized by Google

V. 1472
Eng 1108.84.2

Digitized by Google

SANITARY DRAINAGE OF TENEMENT-HOUSES.*

By Wm. Paul Gerhard, Civil Engineer, New York City.

The term "sanitary drainage" has a peculiarly important meaning if applied to the class of buildings generally known as *tenement-houses.*

Broadly speaking, the word tenement-house signifies any building for rent, occupied by several families living independently of each other. It includes, therefore, a large number of buildings, which have sprung up within the last few years in some of our largest cities, and which are usually called "apartment-houses," or "flats." We shall, however, exclude the latter and limit our remarks more particularly to buildings in cities, intended as Laborers' Dwellings or Workingmen's Homes. These are the buildings of which we usually think when speaking or reading of *tenements*, associated with which word are thoughts of indescribable misery, poverty, squalor, and filth, overcrowding, disease, epidemics, infant mortality, as well as intemperance, loose morals, vice, and crime.

Under such modes of living an isolation in case of an outbreak of epidemic disease becomes much more difficult than in the case of private dwellings or cottages, and the ill influence of bad drainage in particular upon zymotic diseases makes itself more keenly felt. Add to this the general slovenliness in everything relating to domestic cleanliness, the usual bad state of overcrowding, the tainted condition of the atmosphere, and the lack of sun-

* The writer has endeavored to confine himself in this paper to a plain statement of the ordinary defects in plumbing, and to a brief summary of rules for a proper method of "Sanitary Drainage." Those readers who are in search of *detailed* explanations and arguments will find the subject fully discussed from the author's standpoint in his books: '*House Drainage and Sanitary Plumbing*," published by D. Van Nostrand, 2d Edition, 1884, N. Y., and "*Hints on the Drainage and Sewerage of Dwellings*," published by W. T. Comstock, N. Y., 1884.

The State Board of Health, and the writer, are under obligations to Wm. T. Comstock, Esq., publisher, for the permission to use for this paper a large number of cuts from the writer's second-named book.

Digitized by Google

shine in most of these buildings, and it may be easily understood why the mortality-rate, especially that of infants, is so extremely high in buildings of this class.

"The effect of this arrangement of houses," says Charles E. Brace, Esq., "upon the morals of our population, is even more disastrous. In many quarters of the city, family life and the feeling of home are almost unknown; people live in great caravansaries which are hot and stifling in summer, disagreeable in winter, and where children associate together in the worst ways. In many rooms privacy and purity are unattainable, and young girls grow up accustomed to immodesty from their earliest years. Boys herd together in gangs, and learn the practices of crime and vice before they are out of childhood. Even the laborers' families who occupy separate rooms in these buildings have no sense of home. They do not own the house nor any part of it, nor have any interest in it. All that valuable industry which, in the country, a mechanic or laborer applies in odd hours to his little homestead is here lost. The workman spends his leisure hours in the grogshops or at the corner groceries. The general effect of the system is the existence of a proletaire class who have no interest in the permanent well-being of the community, who have no sense of home, and who live without any deep root in the soil, the mere tools of demagogues and designing men."

For ages sanitarians have agreed upon the truth of the old proverb, "*mens sana in corpore sano*," but not until lately has it been more generally recognized that to *live healthfully we need healthful surroundings.*

Let us, then, strike at the root of the evil: before we try to raise the moral habits of a tenement population, let us endeavor to improve the sanitary condition of the workingmen's homes.

In justice to our architects it must be said that they had little if anything to do with the planning of tenement-houses until a few years ago, and it is equally true that since the last few years, when public interest was aroused in this question, a marked improvement in the planning and arrangement of "improved laborers' dwellings," erected in some of our large cities, is apparent.

To the writer's mind there would seem to be no better and worthier deed for philanthropists, no problem more interesting to the architect, no question more important to the *practical* sanitarian, than the improvement of the homes of the laboring class in large

Digitized by Google

cities, for the decent poor are the ones that through sheer necessity are compelled to live in such generally wretched abodes, and hot-beds of disease, vice, and crime.*

The sanitary requirements for tenement-houses are many, but most of them can be provided for without undue sacrifice of economy in building. On the other hand, it is now accepted as true, that landlords or owners, who pay proper attention to the sanitary condition of their houses, will soon be amply repaid by receiving better rents, besides having in their tenements a better class of tenants.

With the exception of the lowest, filthiest class of people—the depraved, vicious, criminal—all tenants will appreciate better sanitary appointments offered to them, and will strive to keep the tenement in proper and cleanly condition.

Among the chief sanitary requirements of tenement-buildings, are:

Personal safety (fire-escapes, ample stairs, strong ceilings);
Pure air, and efficient ventilation;
Plenty of light;
Plenty of space to prevent overcrowding;
Proper drainage and removal of all household wastes;
Plentiful supply of wholesome water;
Proper garbage disposal;
Thorough dryness of cellars and foundation walls.

We limit our consideration to the correct features of a proper removal through plumbing fixtures of the liquid and semi-liquid wastes, in particular of all excretions of the human body, and this is what may be called *sanitary drainage*. Incidentally, other requirements will be referred to, for the serious evils of faulty plumbing-work are intensified through bad ventilation, insufficient lighting, and bad planning with reference to location of plumbing fixtures, while closely connected to a proper arrangement of water-closets is the requirement of a never-ceasing and liberal supply of water for flushing these fixtures.

A proper system of drainage should remove at once, and with great thoroughness, all liquid wastes from the household, together

*See "How the Poor Live," by George R. Sims, London. New York: Scribner & Welford.

Digitized by Google

with the excretions from the human body, to which is sometimes added, the complete removal of surface and sub-soil water. The latter function is important to insure a dry and healthy soil, and to prevent the dampness of habitations, which is a frequent cause of neuralgia and rheumatism, and tends to predispose people to consumption and pulmonary diseases. All foul wastes must be *instantly* removed, for should stagnation occur, putrefaction of the organic matter will soon begin, and gases of decomposition commonly known as "*sewer*" gases—although they are to a large extent generated in human habitations—will endanger the purity of the air of the building. There cannot be the slightest doubt that a large number of preventable diseases, especially those known as "filth-diseases," owe their propagation and spread to germs or micro-organisms, living and multiplying in such gases of decay, and if this is so, it is at once apparent how important it is so to arrange a proper system of tenement-drainage as to prevent any entrance of sewer-gases.

Entrance of sewer air into dwellings is always due to one or more of the following causes:

1. *A defective system of pipes and pipe-joints.*
2. *A defective method of trapping.*
3. *A defective arrangement of fixtures.*

DEFECTS IN THE PIPE SYSTEM.

Under this heading we will consider the pipe connecting the house to the sewer, commonly called the house-drain, although house-*sewer* would be a more correct expression; the vertical soil and waste-pipes, the air-pipes, and vent-pipes, the leader or rain-water pipes, the pipes for yard drainage, for cellar-floor drainage, and finally, the drain pipes, removing the subsoil-water from the site of dwellings.

As the most serious among defects of the house-sewer should be mentioned *leaky joints*. That part of the house-sewer which is outside the house is generally laid with vitrified pipes. In most tenement houses built previous to the last few years, no attempt at jointing the pipes was ever made. The spigot end of one pipe was simply inserted into the socket of the next pipe, thus leaving a large space through which part of the filthy liquid from the household settled away into the ground. It is probably assumed by ignorant builders, or drain-layers, that no harm can result from

Digitized by Google

such mistaken economy. Most of them are entirely indifferent, even if told that a serious contamination of the subsoil near habitations will result from such a pernicious practice. The effect of such leakage on the house-sewer is a quicker choking through accumulation of solid matter left stranded in the pipes.

Accumulations, or even stoppages, are increased by the faulty, haphazard manner of laying such pipes without regard to alignment or grade. Instances are frequent where pipes slope toward the house instead of toward the sewer. Another cause for accumulation of foul matter is the mistaken notion prevalent among builders and drain-layers, that the larger the pipe is the less chance there is for stoppage. Unfortunately, it is ust the other way. The smaller a house-sewer is made within the limits of desired capacity, the more readily will it keep clean. For tenement-houses, having a population not overfastidious in their habits, and having a large number of families living independently of each other, and not having, as in the case of private dwelling-houses, a responsible head of the household, a house sewer should not, as a rule, be smaller than six inches diameter. Even if the greatest care has been bestowed upon the drainage apparatus in building the tenement, the pipes are often made the receptacles of rags, brushes, potato-parings, sticks, ashes, and other substances, not intended to be removed by the pipes, and frequent stoppages are the result.

The house-sewer is often continued of vitrified pipe through the cellar-wall, and into the building, and where no more care upon its joints and the details of pipe-laying is bestowed than outside the building, the soil under it is soon converted into a large cesspool. The pipes frequently break where they pass through the foundation walls, if these settle away, and the whole or a large part of the house sewage may thus be delivered into the ground, while a long time may elapse before such defect is even noticed or remedied.

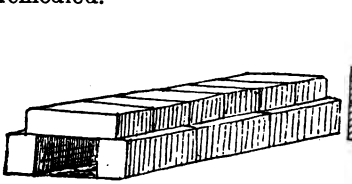


FIG. 1.

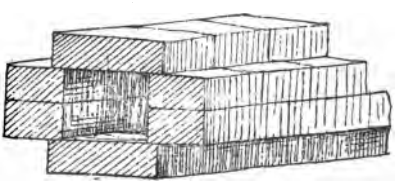


FIG. 2.

Brick conduits (Figs. 1 and 2) under the cellar floor are frequently built to act as sewers. Their shape is generally square, the

Digitized by Google

bottom flat, and the sewage spreads on it in a shallow stream, the velocity of which is too small to remove deposits. The mortar used for such brick-drains is often of the poorest kind; sometimes the conduit is even built of stones, laid dry. (Fig. 3.) Such drains frequently choke up, or they collapse. They are often found completely filled with a putrid filth, the accumulation of years.

In the last few years iron plumber's pipe has been used for the house-sewer inside of buildings. For tenement-houses light soil-pipe, *i. e.*, pipe having a thickness of only $\frac{1}{8}$ inch, is used almost

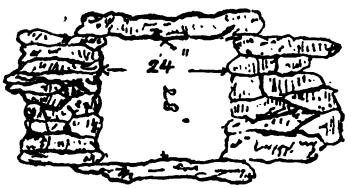


FIG. 3.

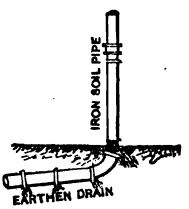


FIG. 4.

exclusively. This pipe has well been called a "trashy" article of manufacture, for it is often full of cracks or sand-flaws, which defects are occasionally covered up with a coating of coal-tar pitch. The joints in light soil-pipe, owing to the weakness of the hub, are seldom properly made, so as to be able to withstand internal pressure when tested.*

In the case of contract work, especially in tenements built by the speculative builder, almost anything else but lead is used for filling the space at each joint. Putty is largely stuffed into the joints, or cement, mortar, red lead, mixed with putty, and other substitutes. Occasionally a joint is filled with paper and sand. Possibly a small amount of lead is poured on top of such fraudulent joints to give them the appearance, at a hasty examination, of being properly made. Such examinations of the plumber's work were not often made in tenement-houses, owing to indifference of both owner and contractor. Testing the pipes and joints by water pressure, or by the smoke or peppermint test, was never thought of. The consequence is a steady leakage of sewer gas from the top of the joint, and drippings of sewage at its bottom.

* For an account of a recent test of light and heavy plumber's soil-pipe, of various makers, and of lead-caulked joints in such pipe, see the *Sanitary Engineer*, Vol. 9, No. 1 (December 6, 1883).

Digitized by Google

Branch drains were connected to the main house-drain with right-angled junctions causing eddies and deposits in the pipes. The junction between soil-pipes or upright waste-pipes and the drain in the cellar was equally defective. Sometimes the horizontal drain settles away from the upright pipe, and through the large aperture between both pipes, sewage matter is poured on to the ground, instead of being carried away in the pipes. (Fig. 4.)

What we have said of imperfect joints in the horizontal iron drain-pipes is equally true of upright soil and waste-pipes. There are few, if any soil-pipe stacks in older tenement-houses that are not defective in material as well as in workmanship. In buildings erected more than twenty years ago, it is common to find lead

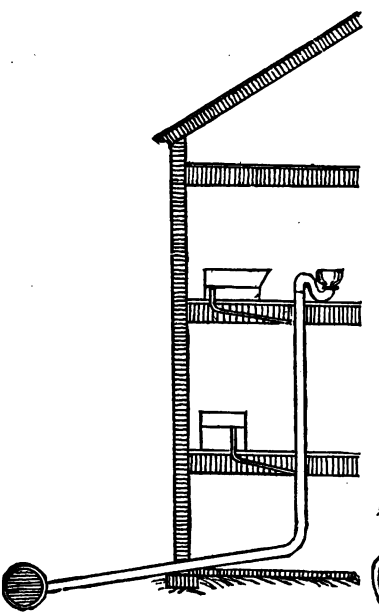


FIG. 5.

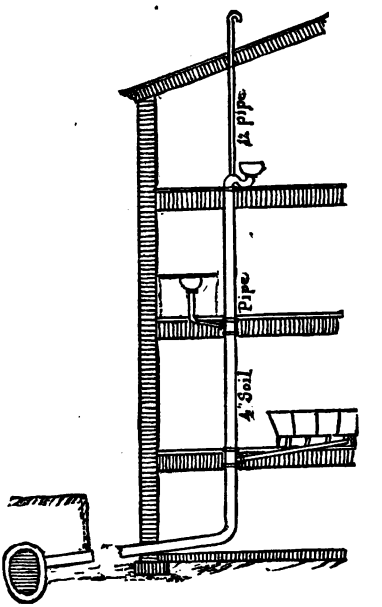


FIG. 6.

pipe used for large soil and waste-pipes. This is at least equally, if not more objectionable than the common light iron soil-pipe. For lead pipes are soon corroded and honeycombed by the action of putrid soil-pipe gases; moreover, they are apt to sag and settle on account of their weight, and they are exposed to the danger of having nails driven through them, a frequent cause of unexplained

Digitized by Google

bad odors in older houses. The corrosive action on lead pipes is aggravated by the entire lack of ventilation of lead soil-pipes put in buildings, twenty years or more ago. Such is equally true of iron soil and waste-pipes, and of smaller lead and iron waste-pipes. (Fig. 5.) The writer has been shown, in a plumber's shop, cast-iron plumber's soil-pipe, which had been in a building about seven years, corroded and perforated with numerous holes on account of stagnation of sewer-gas in the soil-pipe.

In tenements of more recent date an attempt to ventilate the soil-pipe is occasionally made by running a small pipe up to and through the roof. (Fig. 6.) Of course, such a small opening on

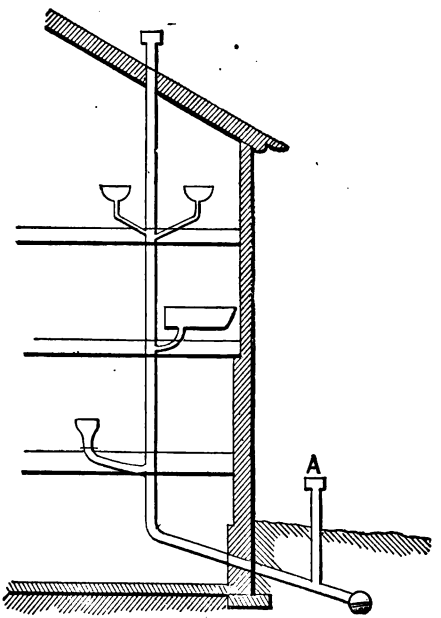


FIG. 7.

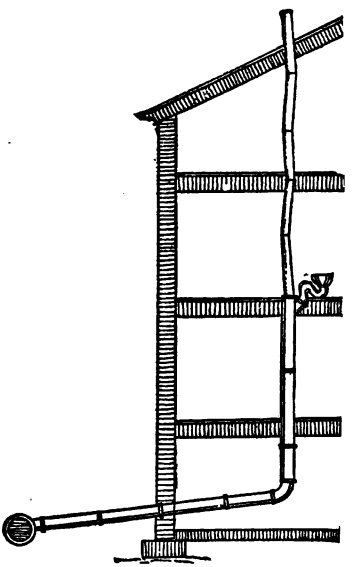


FIG. 8.

the roof is of little use, unless a second opening at the foot of the house-sewer is made. Even if this is arranged, the soil-pipe ought to be extended at least full size through the roof. (Fig. 7.) Such vent-pipes are often run with galvanized sheet-iron or tin pipes (Fig. 8), which are absolutely inadmissible for such purpose in good work.

To locate the soil-pipe top near attic windows or near ventilating shafts or chimney tops is another error of construction which

Digitized by Google

causes at times sewer-gas to return through these channels into a building. Smaller waste-pipes, if run through the roof, are often found clogged in winter time, through snow or hoar frost. No pipe extension through the roof should, therefore, be less than four inches in diameter.

The top of soil or waste pipes, if extended through the roof, is most always covered with a "ventilating" cap (Fig. 10), (probably so-called—*lucus a non lucendo*—because it does *not* help to ventilate), or with a return bend (Fig. 11). The object of these contrivances is to prevent any malicious choking of the soil-pipes through stones or other articles which mischievous children of a tenement-house population are very apt to throw into the pipes. There is no

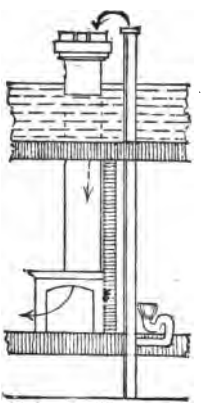


FIG. 9.

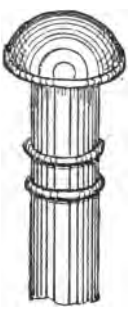


FIG. 10.

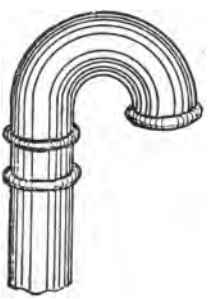


FIG. 11.

doubt that an open-mouthed soil-pipe acts more efficiently than a pipe covered with a cowl or cap. Wherever possible, pipe extensions in tenement-houses should be run at least six feet above the roof, and preferably higher, the mouth being then left entirely open. Where this cannot be done a copper wire basket on top of the pipe will prevent the throwing in of larger articles, or else some of the simpler forms of cowls may be used; all of these being preferable to the return bend, which greatly impedes ventilation.

The foot opening, commonly called fresh-air inlet (A., Fig. 7), is not found in any but the most recently-built tenement-houses. Occasionally a reversed current occurs at such inlet, and a puff of "sewer-gas" is driven out at the opening. It must, therefore, in order to be inoffensive, be located away from windows. But for

Digitized by Google

the danger of its clogging in winter time through snow and ice, it would be best to run the fresh-air pipe to a catch-basin at the curb, covered with an air grating. Wherever there is a strip of parking between the building and the sidewalk, a manhole may

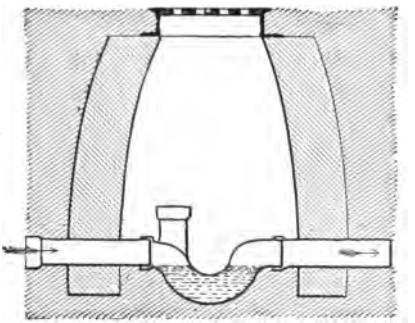


FIG. 12.

be built in which the trap is placed and the fresh-air pipe may terminate in this manhole, which may be covered with an open grating to admit the outer air. (Fig. 12.) Instead of a manhole an inspection shaft is occasionally built of glazed terra cotta pipes covered with an open grating. (Fig. 13.)

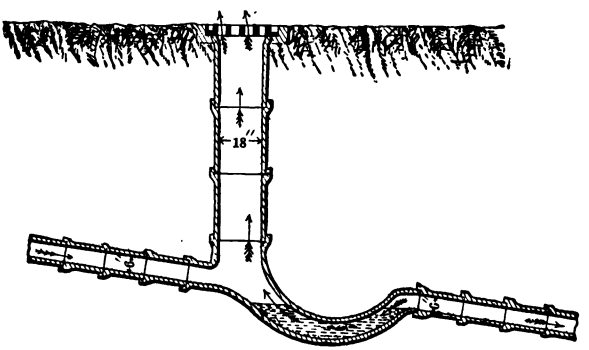


FIG. 13.

Of the smaller branch waste-pipes, of overflow-pipes, and drip-pipes we shall speak when discussing the plumbing fixtures.

Leader or rain-water pipes should not, if inside a building, be made of metal, and they should not, as is so often the case with tenement-houses, serve as soil-pipes, or as vents for soil-pipes.

Digitized by Google

Pipes for yard drainage should be of ample size to remove the rain-water falling on yards, and should join the main house sewer by proper Y branches.

The house-sewer has often a branch running to a gully located in the cellar floor to remove cellar water. Such an opening from the main house-sewer into the cellar is decidedly objectionable and there is rarely a necessity for it. It is often the cause of the flooding of cellars where sewers are gorged by storm-water or where the tide backs up into the house drain. The foul deposit left and spread in such cases on the cellar floor may become the cause of serious disease in tenements.

Drain-pipes, if such are used for the drainage of the sub soil of tenement-houses, consist commonly of what is called a "blind drain," this being a trench dug with some fall and filled with loose broken stones along or under the foundation walls. It generally connects with the house-sewer, and even if trapped causes the sewer air to enter the cellar in periods of drought. There must always be a thorough disconnection between such drain and the house-sewer.

DEFECTS OF TRAPPING.

Wherever there is an opening in the drainage system inside a dwelling, a barrier or water-dam is or should be placed on the line of the waste pipe to prevent gases of decomposition from

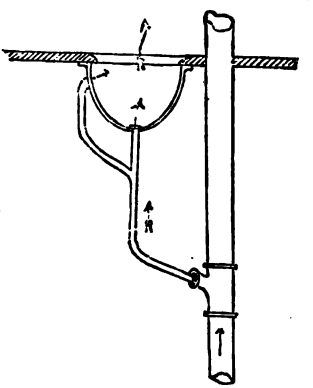


FIG. 14.

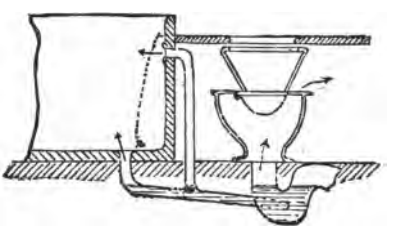


FIG. 15.

entering through such opening. Such barriers are called "traps." Defective trapping of drains and fixtures is, next to defective pipes and joints, the most frequent cause of the entrance of sewer air into tenement-houses.

Digitized by Google

The most serious defect is the entire absence of traps under fixtures (see Fig. 14), caused either by criminal carelessness or stupidity of mechanics, or else through equally criminal intention of "skin" builders or contractors. I do not refer in this connection to special systems of soil pipe ventilation with induced downward currents through trapless fixtures and into the pipes, which systems however cannot, in my opinion, be considered reliable *at all times*. They are certainly entirely inapplicable to the drainage of tenement houses.

Not less defective is a method of trapping frequently found in older buildings by placing one large trap at the foot of the soil-pipe serving for a number of plumbing fixtures on different stories. A little reflection must convince any one that enough sewer gas is created in the soil-pipe stack, in the branch waste-pipes, and in the overflow-pipes which are then in open communication with the interior of the building, to cause serious sickness.

It is yet much more common to find several fixtures on one floor and close together, trapped by only one trap (for instance, a

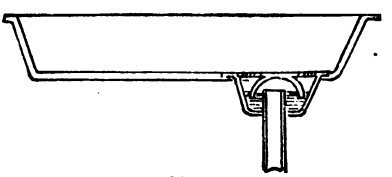


FIG. 16.

water-closet trap), into which the wastes from the bath-tub or the sink, if this is near by, or from a bowl are run below the water-line. (Fig. 15.) A slight sagging or displacement of the trap is sufficient to render the trapping ineffective. What is, in such case, to prevent putrid gases from the water-closet container from escaping at the bath or sink? On the other hand the foul water of the water-closet trap is apt to back up a long distance in the bath waste, keeping it continually foul and allowing the foul water to evaporate at the opening in the bath-tub.

In recently-built tenement-houses we may find a separate trap under each water-closet, sink, and tub. But here is not the end of defects. The sink trap is usually a bell-trap, in combination with a loose strainer in the bottom of the sink. (Fig. 16.) Bell-traps are the worst possible devices for disconnecting sinks from the drain-pipes. Their seal is always quite insufficient, they readily

Digitized by Google

choke, and what is worst, in cleaning the sink the loose strainer is readily lifted and all sorts of rubbish brushed into the waste-pipe, which is thus stopped up at frequent intervals. As long as the strainer is removed soil-pipe gases can readily pass into the

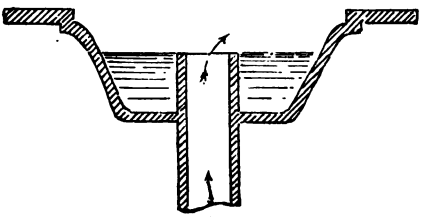


FIG. 17.

kitchen. (Fig. 17.) At times such strainers are not even replaced or else they may be lost and entirely forgotten. The tenants, who are almost always ignorant in regard to such subjects, will then be constantly compelled to breathe sewer air and, with unventilated soil-pipes and untrapped connections to foul street-sewers, the tenements are literally turned into "hot-beds of disease." To realize the possible consequences of such defective sink arrangements we must bear in mind that in tenement-houses the kitchen most always serves as a living-room and not unfrequently as a bed-room. Can we then wonder at the frequent occurrence of scarlet fever or diphtheria with children sleeping in such pest-holes?

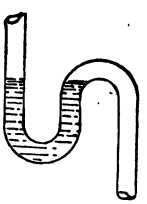


FIG. 18.

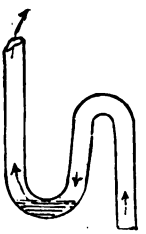


FIG. 19.

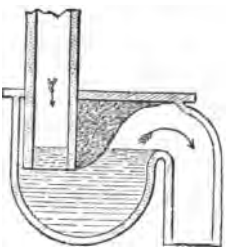


FIG. 20.

A few tenements have possibly an S trap (Fig. 18) under the sink. This too is open to severe objections. If a discharge from a sink or water-closet of an upper story occurs, the rush of water past the sink waste connection may create sufficient suction to remove a part or all of the water in the S trap by siphonage, leaving the opening in the sink unprotected against soil-pipe gases. (Fig. 19.) If the vertical waste-pipes are not extended through the roof,

Digitized by Google

back-pressure in the pipes often forces bubbles of noxious gases through the water-seal of the S trap, which rarely exceeds one and one-half inches in depth. Furthermore, with unventilated soil and waste-pipes, the water in traps constantly absorbs gases which are afterwards given off at the house side of the trap. Occasionally a sink or tub is not used in an empty tenement for a long period of time, and as the water in the traps is subject to constant evaporation, a passage is soon open for the entrance of the deadly gas, which saturates walls, ceilings, floors, and greets the new tenant when he moves in with its faint, peculiarly musty odor.

In the cheapest sort of tenement-houses the water-closets are sometimes left entirely untrapped, or else there is but one trap at the foot of the soil-pipe meant to serve for all closets on that stack. The pipe itself is as described before, generally unventilated. Sewer gases continually enter the tenements, and this condition of things occurs occasionally where the water-closets are placed in a bedroom, or in a small closet adjoining a sleeping-apartment. It is no exaggeration to say that the man who is guilty of such construction is committing murder or manslaughter, and should be tried in the courts for such offence accordingly. The atmosphere

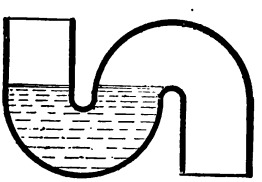


FIG. 21.

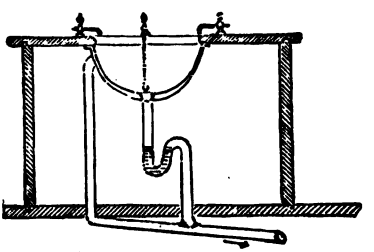


FIG. 22.

is seldom better if the water-closets are placed in some dark, unventilated place in the stair-case hall. The rooms are in close communication with the hall, and as this has usually no ventilation whatever, the atmosphere of the rooms is poisoned by degrees.

Should the water-closet have a trap it is in old houses of the D shape, which is readily converted into a receptacle of filth. (Fig. 20.) Where S traps are used (Fig. 21) they are almost always unprotected against siphonage, loss of seal by momentum, back pressure and absorption of gases.

Some of the better class of tenements have bath-tubs, wash-

Digitized by Google

bowls, or laundry-tubs. The wastes from bath-tubs or bowls are either untrapped or trapped by an unventilated running trap, which is quickly siphoned. The overflow-pipe is often connected to the waste-pipe beyond the trap. (Fig. 22.) Laundry tubs show the same defects.

Drip pipes to remove water from "safes" in case of leakage or overflow are generally directly connected to the soil or waste pipes. Sometimes they are trapped, but the water in such a trap readily evaporates, leaving an open passage for gases. Such an arrangement is therefore equally unreliable.

A further serious defect is the absence of a trap on the main drain. (Figs. 5, 6, 7, 8.) If the tenement sewer is untrapped the pipes within the building are filled not only with gases of decomposition due to organic matter attaching to the inside of soil and waste-pipes, but the gases from the street sewer freely enter the

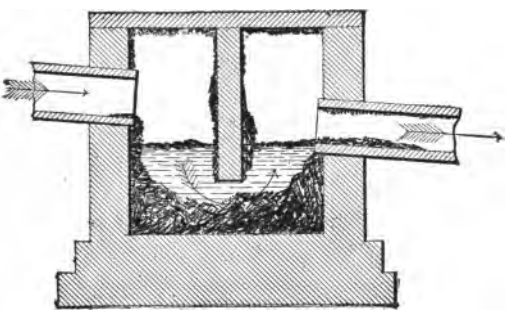


FIG. 23.

house. The conditions are infinitely worse if the tenement sewer discharges into a cesspool. Unventilated soil-pipes thus become a perfect reservoir holding sewer gases, and the latter are constantly passing into the living-rooms. This condition of affairs accounts for the overwhelming stench and nauseating odor pervading some tenements from cellar to attic. Drains of older buildings are sometimes cut off from the sewer or cesspool by a large brick trap, generally known as a "mason's or cesspool trap." (Fig. 23.) This soon accumulates filth as shown, and is extremely objectionable on this account.

There is often a gully in the cellar-floor (Fig. 24), to remove water from the cellar, and this is generally trapped by a bell-trap, the defects of which have been explained heretofore. But even

Digitized by Google

where an S-trap is used, evaporation soon destroys its water-seal, and noxious sewer air freely enters the cellar. Such openings from the drain in the cellar floor are extremely objectionable in all buildings, and should never be permitted in tenement-houses.

The yard drains for removal of surface water are generally trapped by a "cesspool" trap, which is a bell-trap similar to the

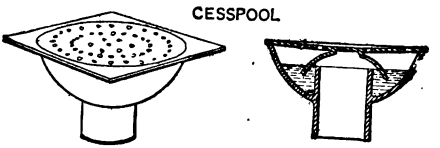


FIG. 24.

trap in the cellar floor. This freezes in winter time, or clogs from dirt, and creates in both cases, an intolerable nuisance in the yard; in the summer time its water evaporates and the children of the tenement-house population, when playing in the yard, are compelled to breathe sewer-air, even if they are out-of-doors. Bad odors are frequently carried into basement rooms, owing to foul and untrapped yard-drains. Untrapped leaders are fully as bad in this respect, and the ordinary seal of an S trap has not sufficient resistance against evaporation during periods of drought, if placed at the bottom of a rain-water stack.

DEFECTS AS REGARDS FIXTURES.

Plumbing in tenement-houses is usually restricted to water-closets and kitchen sinks. Occasionally a slop-sink or slop-hopper is placed in the stair-case hall for the common use of all families on each floor. It is not often that laundry tubs are fitted up; the common portable wash-tubs are in general use, and are emptied into the sink in the kitchen. A bath-tub in a tenement, although very desirable on the score of cleanliness and health, is looked upon as a luxury, and is only fitted up in the higher-priced tenements.

Fixtures are often scattered about in tenements, instead of being placed in vertical groups. The consequence is that a large number of branch waste-pipes are run between floors, to the distant soil-pipe, generally without any fall, and almost always with sags and bends in the pipe, caused by insufficient support of the pipes, and likewise from the effects of the contraction and expansion through changes of temperature.

Digitized by Google

The general arrangement of the plumbing work is usually such as to make a thorough sanitary inspection very difficult. This is true, not only as regards the fixtures, but also as regards the traps and the pipes. It is the result of the pernicious tendency to bury as much of the plumbing as possible out of sight. To quote from a paper on "House Inspection," by Professor Fleeming Jenkin of Edinburgh:

"It is commonly supposed that to investigate the sanitary fittings of a house thoroughly, it would be necessary to rip up floors, tear down panelling, break open plaster, and lift the pavement of the ground floor. . . . . With a more rational system of arranging the plumbing work in a house, the pipes could be readily inspected without this demolition, and it is heartily to be desired that architects should give their minds to arranging every pipe so that every yard of it can be seen with little trouble, and repaired without incon-

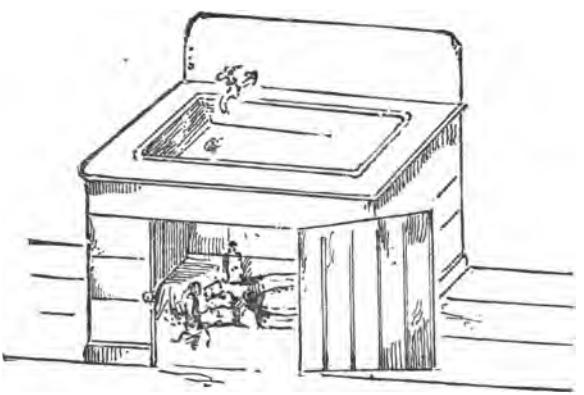


FIG. 25.

venience. . . . . The first principle an engineer is taught in the drawing-office is this: every part of a machine must be readily accessible for inspection and repair. The water and drain systems of a house constitute a large and complex system, but architects and builders have sadly neglected this condition of accessibility."

The sink, which is always placed in the kitchen, is usually enclosed with tight carpentry. The space underneath the sink is used for the storage of all kinds of rags, musty shoes, dirty towels, and other filth (Fig. 25), and an indescribable odor is escaping from such never-aired enclosure, as well as from the sink itself, which, as mentioned above, is rarely properly trapped. Large

Digitized by Google

tenement-house families use the kitchen not only as living and dining room, but also as a laundry, and frequently as a bedroom, and with the usual absence of any ventilation, the atmosphere of such a tenement-house kitchen—a pestiferous mixture of noxious gases from the drains, foul vapors from boiling of soiled linen, odors from cooking, and exhalations of filthy bedding—is such as completely to overpower the organs of smell of any casual visitor.

However, the atmosphere in the water-closet apartments is something infinitely worse. This is due largely, as we have seen, to the bad manner of trapping the closets. But the apparatus is in itself cause enough for the bad odors. Water-closets in tenement-houses

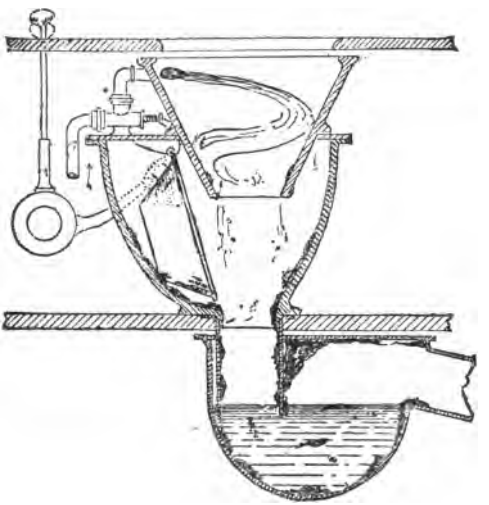


FIG. 26.

are, with rare exceptions, either pan-closets (Fig. 26) or bad hopper-closets. So much has been said about the utter worthlessness of pan-closets for all purposes, that I may well omit to mention their faults. They are retainers and containers of human filth, and should not be tolerated in any place intended to shelter human beings.

There are good and bad hopper-closets. As the latter are, unfortunately, the cheaper ones, they are preferred by most builders of tenement-houses. They become extremely filthy and disgusting in appearance, owing largely to the improper method of flushing directly from the supply pipes, and furthermore, owing to the often

Digitized by Google

insufficient water supply. For it frequently happens that the water-pressure in the mains is so much reduced as to allow the water to rise only to the lower stories, or the supply-pipe is, on the score of economy, so small, that if water is drawn on a lower story, water does not run at any of the faucets in upper stories. Water-tanks are extremely rare in tenements, and pumps to force the water up to them still more so. Thus the closets often remain without a flush, and this is more liable to occur in day-time, when the closets are in greatest use.

A serious danger to the water-supply is caused by such insufficient pressure in the supply pipes. For if the flush is started, no water flows into the closet-bowl; *there is often a strong suction into the supply-pipe*, and polluted air and possibly disease-germs—occasionally even foul matter from the bowl—are sucked into the pipes, thus poisoning the drinking water. Whoever is in doubt about any illness due to pollution of water through such defective closet arrangement should read the report by Dr. Buchanan, on an outbreak of enteric fever in Caius College, Cambridge, England.*

There should be placed over each closet, or group of water-closets, a suitable flushing-cistern. Hopper closets, especially, require such a flushing-cistern with a large supply-pipe from the cistern to the closet-bowl, so that the water may come down in a large quantity, and with such rush as effectually to cleanse the bowl and expel all foul matter from the trap.

Not content with supplying the tenement with a defective and unsanitary water-closet apparatus, the builder encloses the fixture with tight carpentry, and finishes the whole with a faulty arrangement of the seat, whereby the latter and the wood-work become spattered with slop-water or urine, should the closet be used to pour out chamber slops, or be used by men or boys as a urinal. The floor in the apartment is kept continually damp through such spilling or through leakage of the closet valve. Woodwork readily absorbs foul liquids, and constantly emits noxious odors, which, combined with the foul gases from soil in the closet-bowl, and soil-pipe air, issuing from defective traps, defective joints, and defective drip-pipe connections (Fig. 27), all suffice to exert an unwholesome influence upon the health of delicate women and children during even a short stay in such places.

* See Reports of the Medical Officer of the Privy Council and Local Government Board, England, New Series, No. II. 1874.

Digitized by Google

Water-closets for tenement-houses are often placed in the cellar of the building. This is objectionable on many accounts. The cellar is usually dark, damp, and ill-ventilated. Important as it is to have water-closets located in well-lighted and well-ventilated rooms in private dwellings, it is imperative to give to water-closets in tenements a proper location. Darkness in such a case is identical with misuse of the fixtures, uncleanliness, general bad habits, vice, and even crime. Not only should there be a liberal water-supply on each floor of a tenement, but there should be water-closets on every floor as well. These will greatly add to the comfort of the laborers' wives, and of invalids. Water-closets placed either in a cellar or in an out-house in the yard are further objectionable,

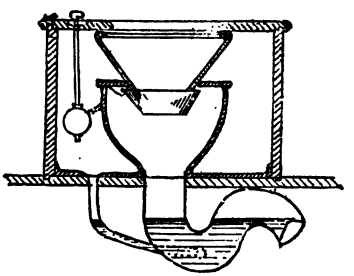


FIG. 27.

as none of the tenants will feel the responsibility of keeping such places in decent condition. The arrangement might answer, where a janitor takes care of the whole tenement, but this—although desirable for many reasons—is rarely the case.

In double tenements, with four families on each floor, there is often, owing to defective planning, want of space to locate the water-closets in a proper place. They are, therefore, placed in a bedroom, or in a dark, unventilated closet adjoining it. Such a location cannot be too strongly condemned. The diseases believed to be caused more or less directly by defective water-closet arrangements are many and serious. There are, first, the bowel diseases, such as diarrhœa, dysentery, cholera; then we have enteric fever, diphtheria, scarlet fever, typhus fever; furthermore, we have sore throat, erysipelas; finally, we have diseases due to blood-poisoning, such as septicaemia, pyaemia, and a vast amount of puerperal fever. But aside from acute illness, such wholesale poisoning of the air in bedrooms results in general debility, lowering of vitality, frequent

Digitized by Google

headache, nervousness, asphyxia, nausea, etc. It is well known that the human system has less resistance to such evil influences during sleep. *It is, therefore, absolutely inadmissible to place a water-closet or any other plumbing fixture in any sleeping-apartment of a tenement.*

Less dangerous, though not much better as regards cleanliness, proper use and danger from bad gases, is the arrangement of the water-closets—or the bath-room, if such is provided—in a small room or closet, adjoining the main staircase hall. These rooms are usually dark and without any provision for frequent change of air. The unwholesome gases, finding no other exit, soon pass into the staircase hall and fill the whole tenement. The water-closet rooms must either have an outside window, or else they must receive light and air from a special light and air shaft. By arranging the closets on different floors in vertical groups, such light and air wells may be constructed without great additional outlay of money. The Plumbing Regulations of the New York City Board of Health require "*shafts not less than three square feet in area in tenement-houses, to ventilate interior water-closets.*"* It seems hardly necessary to add that such water-closet shafts should not be used to ventilate living or bed-rooms of a tenement. Less generally understood is the fact that such air-wells, as usually constructed, are of little avail in establishing a ventilation of the water-closet apartments. The air in air-shafts, *open only at the top*, is most of the time in a state of stagnation, and chemical and microscopical analysis readily reveals its unwholesome pollution. Ventilation signifies change of air, *i. e.*, the expulsion of fouled air, and its continuous and gradual replacement by pure air. To do this effectually, *two* openings are always required. Such air-shafts should therefore communicate with the outer air not only at the top, but at or near the bottom as well. An effort is being made lately to substitute for such air and light-shafts open courts, at least for the better class of tenement-houses, thus giving to every room or closet on each floor a direct opening to the outer air.†

A fixture which becomes not less foul and ill-smelling than a water-closet is a slop-hopper or a slop-sink. It is sometimes ar-

* See Regulations of the New York Board of Health for *Light* and *Ventilation* in Tenement-Houses.

† The writer is indebted to J. C. Collins, Esq., Chief of the Division of Tenement and Plumbing Plans at the New York City Health Department, for valuable information on this subject.

Digitized by Google

ranged in double tenements, with three or four families on one floor, to empty slops into, especially if the water-closets are located in the basement or in the rear yard. The water remaining in the trap of such slop-hoppers is foul and is only driven out by a further addition of foul water. Moreover, the whole surface of the sink becomes coated with a filthy slime, and emits not less sickening odors than those from the water in the trap. If water is poured down through one of the sinks on upper floors, the traps of sinks on the lower floors, located on the same pipe-stack, are almost always emptied by siphonage, and the trap of the upper sink loses its water through momentum. An opening is thus made for the entrance of soil pipe gases. Whenever special slop-hoppers or slop-sinks are fitted up, they must be constructed similar to water-closets. They must be thoroughly trapped, and must have a flushing cistern to thoroughly cleanse the sink and trap after each use.

Such is, briefly stated, the prevalent condition of the drainage apparatus in many tenement-houses. A large share of the blame rests on the "speculative" builder who studies not how to economize, but how to reap the largest amount of profit by using cheap, worthless materials and employing inferior workmen. Part of the responsibility devolves on the plumber for taking contracts at prices at which he knows a perfect and substantial job cannot be done. Finally, in not a few cases where the owner is willing to pay for plain but good plumbing, the plumber's ignorance or dishonesty or both must account for untrapped drains, unventilated soil-pipes, and ill-arranged fixtures.

There is but one remedy for this condition of affairs; it is the thorough inspection by competent inspectors, employed by the city health authorities, of all buildings hereafter erected. Such inspection during construction will be of the greatest service for tenement-houses, the population of which is unable, even if it recognized the serious evil, to help or to protect itself. Inspections of the drainage system, however, are desirable for *all* classes of dwellings; first, because much of the work is of necessity hidden from view after the building is completed; second, because even dwellings of the better class may be rented or change their owner.

Plumbing work in all tenements hereafter to be erected should be done according to some code of standard rules compiled by the Board of Health or sanitary authorities. Many large cities, for

Digitized by Google

instance, Washington, New York, Brooklyn, Chicago, Boston, Philadelphia, and several smaller cities and towns, have such rules in force, and the success of such system of plumbing, inspection has been marked everywhere.

As a guide in establishing such rules the writer offers the following:

SUGGESTIONS FOR THE "SANITARY DRAINAGE" OF TENEMENT-HOUSES.

SYSTEM OF PIPES.

Wherever a sewer is built in the street or at the rear of a lot, the tenement must be connected to such sewer through a proper pipe conduit, and no cesspool must be permitted for the drainage of such tenement and lot. Each tenement-house must have an independent sewer connection.

For the house-sewer outside the building use strong vitrified or cement pipe. Use iron pipe if the ground is made ground or in quicksand.

Earthen or vitrified pipe must be perfectly straight, circular and true in section, of uniform thickness, free from cracks or flaws, hard burnt, smooth on the inside and highly glazed.

Cement pipe should be made of best Portland Cement, true in section, of a sufficient thickness and rendered as smooth as possible on the inside.

Cast-iron pipes should be not less than three eighths inch thick, of a uniform thickness, truly cylindrical, of a homogeneous texture, with smooth inside surface, free from flaws or other defects, and coated with coal-tar pitch, or an equivalent substance, to prevent corrosion.

Joints in vitrified pipe and in cement pipe should be made with pure Portland Cement. Particular care is required in filling the bottom part of the joint thoroughly with cement, and in preventing any cement from protruding at the inside of joints.

It is important that the pipes, whether earthen, cement or iron pipes, should be firmly bedded in the trench. Grooves must be cut for the hubs in order to give a firm bearing to the whole length of the pipe.

The house-sewer must be laid at least three feet deep to protect it against frost.

Digitized by Google

The house-sewer must be laid in straight lines, and changes of direction should be made with curved pipes of large radius. All branch drains must join the main house-sewer by Y branches. Tee branches should never be used for junctions. If the house-sewer is unusually long it is recommended to provide manholes as a means of access in case of repairs or inspection.

Before refilling the trench the pipe line should be tested by hydraulic pressure.

For tenement-houses with more than four families it is seldom safe to use a smaller size than six inches diameter for the house-sewer except where the tenants can be relied upon to use the plumbing fixtures with intelligence and proper care. In the latter case a five or four inch sewer would have ample capacity and would prove to be more self-cleansing.

The ordinary velocity of flow in the house-sewer should not be less than three feet per second, and a velocity of four or four and one-half feet is desirable. The inclination to be given to the house-sewer must be determined accordingly. A six-inch pipe requires an inclination of 1 in 138 and 1 in 61.2 to create a velocity of flow in the pipe of 3 and 4½ ft. per second respectively. This is true supposing the sewer to run full or half full. As the ordinary or dry-weather flow from all plumbing fixtures in a tenement is not at all likely to fill a house-sewer *half full*, it is evident that a greater inclination than above stated is necessary to prevent deposits in the pipes. The inclination should be calculated with reference to the *maximum* flow of household waste-water exclusive of storm-water.

If the required inclination cannot be given to the house-sewer it is extremely desirable that means for frequent artificial flushing should be provided for.

The house-sewer inside of the tenement *must* be of heavy iron pipe.

It should preferably be carried *in sight* along the cellar wall, supported at intervals by strong brick piers.

If it must be laid below the cellar floor, access-holes and cleaning hand-holes must be provided and the trench must not be closed before the drain has been inspected.

Cleaning hand-holes should be provided near all junctions with branch drains or with vertical soil and waste-pipes, also at or near the running-trap and near bends.

Digitized by Google

The pipe-system in the cellar should be as compact and concentrated as possible. If the rain-water is taken into the house-sewer, it is well to connect leaders with the upper ends of the drains, thereby securing an occasional thorough scouring to the *whole length* of the house-sewer.

As to the size and inclination of the house-sewer inside the dwelling, follow rules given for outside drains.

No junction should be made at right angles; all changes in direction must be accomplished with Y branches and 45° bends, or with 90° bends of large radius.

All soil, waste, and air-pipes inside of a tenement-house should be of heavy iron pipe (with the exception of the short branches from the fixtures).

Each soil pipe, waste-pipe, and air-pipe must have thoroughly air and water-tight joints and the pipes must be of a sound material, free from any defect.

Soil and waste-pipes must always be arranged as direct as possible. Each stack should run up perfectly straight, if possible. The fewer offsets the stack has the better. Long branch wastes under floors must be avoided. All this can be readily attained in tenement-houses by placing the fixtures of different floors one above the other in vertical groups.

It is preferable to keep all soil, waste, and air-pipes in sight. If they are placed in recesses or in partitions, these should be covered with wooden boards fastened with screws and readily removable. No pipe should ever be buried entirely out of sight.

Where water-closets or bath-rooms are located around a light-and-air-well, it is to be recommended to place the pipes in this shaft.

Waste-pipes for vertical groups of kitchen sinks in tenements should run, wherever practicable, along the outside of a heated flue (kitchen chimney), as this will further an upward draft in the pipes.

The soil-and-waste-pipe system must be thoroughly ventilated and should have no long "dead ends" of pipe. Each soil-pipe and each waste-pipe must extend as straight as possible, and at least full-size from cellar to above the roof. (Fig. 28.)

The extensions above the roof should in all cases be not less

Digitized by Google

than two feet high, so as to expose the pipe-mouths freely to currents of air.

Pipe extensions above the roof must be located as remote as

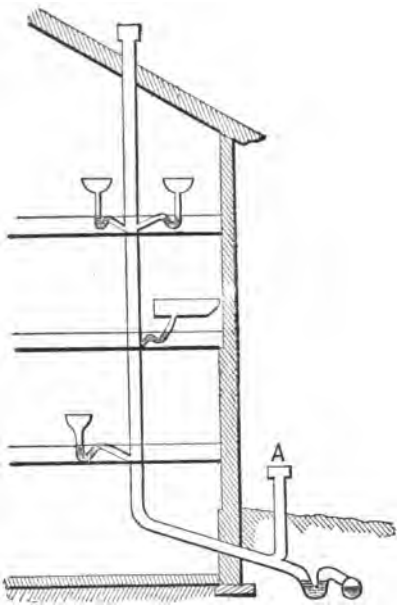


FIG. 28.

possible from ventilating shafts, chimney-flues, ventilating skylights, air-and-light-wells, etc.

No pipe extension through and above the roof should be less than four inches in diameter; smaller pipes clog up in winter time.

All pipe-mouths above the roof must be kept *wide open*. None of the numerous patent ventilators are preferable to an open-mouthed pipe. It should be remembered that the object of soil and waste-pipe extensions above the roof is, above anything else, to prevent stagnation of air in the pipes. No violent air-currents are required in soil or waste-pipes. Return-bends on top of a pipe cause stagnation and are objectionable on this account; so-called ventilating caps freeze up and prevent ventilation in winter time.

To protect pipes on roofs of tenement-houses from malicious obstructions run the extensions at least six feet high above the roof.

To insure a full circulation of fresh air through the pipes, a fresh-air inlet-pipe A (Fig. 28), of four inches diameter, must be

Digitized by Google

provided in the house-drain, preferably located just inside of the trap in the drain, and its mouth run to a point well remote from windows.

Soil-pipes should not be larger than four inches inside diameter, which size of pipe will answer even for half-a-dozen or more water-closets and sinks.

Vertical waste-pipes for kitchen sinks or tubs need not be larger than two inches diameter; where they receive discharges from slop-hoppers they should be made three inches in diameter.

Each stack of soil or waste-pipe must have fittings (Y branches, half Y branches or Tee branches) in proper position and at proper height to receive the flow from fixtures. It is preferable to discharge each fixture directly and separately into the upright stack, and this is easily accomplished where the soil-pipe system is located in a light shaft.

Junctions between horizontal branch wastes and vertical soil-pipes need not be made with Y branches; Tee branches, especially if the flow line is arranged in an easy curve, are not objectionable, nor is it objectionable to run the small wastes from tubs into large soil-pipes by means of right-angled connections. An oblique connection in the direction of the flow is *desirable*, but practical considerations favor a direct right-angled connection.

Vertical pipe-stacks must be strongly supported at the junction with the horizontal main sewer in the cellar in order to prevent settlement, which would tend to loosen the joints at the fixtures. The junction must be made with a Y branch and 45° bends or with an elbow-fitting of large radius.

For soil-pipes and vertical stacks of waste and air-pipes use either heavy cast-iron pipes or wrought-iron pipes. Both must be efficiently coated, after being highly heated, with coal-tar or asphalt, or else they should be treated with the Bower-Barff, or other rustless process, to prevent corrosion in the pipes. Both cast-iron and wrought-iron pipes must be tested *before use* under hydraulic pressure for any defects in the pipe. Both must be truly cylindrical and of a *uniform thickness* of *not less than one-fourth inch.* Cast-iron pipes must be especially closely scrutinized for *uniformity* of thickness of shell.

Joints in cast-iron pipe must be made by inserting a gasket of picked oakum into the joint and pouring molten soft lead from a large ladle into the remaining space. After cooling and shrinking

Digitized by Google

the lead must be thoroughly caulked with caulking tools to insure *tight* joints.

Joints in wrought-iron pipe are made with screw threads cut

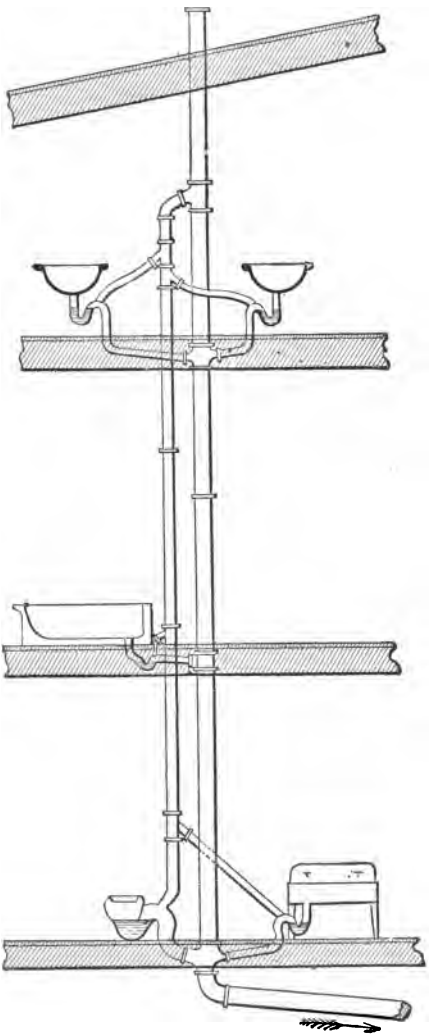


FIG. 29.

on the ends of pipe and into the shoulder of fittings. A paste of red and white lead mixed is used to act as a lubricant and to make up for imperfections in the thread. The pipes are screwed

Digitized by Google

together by means of chain pipe-tongs and the joints must be made as tight as if the pipes were to carry steam under pressure.

Vertical lines of air-pipe must be of cast-iron with well caulked joints or of wrought-iron with steam-tight screw joints. Each line should be as straight as possible and be at least two inches in diameter, increasing at the upper floors, as the height of the building increases, to three and four inches diameter. The upper end of air-pipes is either run through the roof (never smaller than

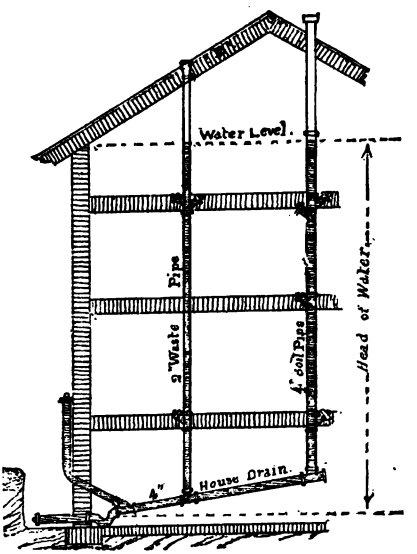


FIG. 30.

four inches in size) or it is branched into the adjoining soil or waste-pipe above the highest fixture. (Fig. 29.)

Each vertical line of air-pipe must have fittings of proper size to connect branch air-pipes to it.

Air-pipes must not be used as waste or overflow-pipes.

To run air-pipes into flues is as inadmissible as running soil or waste-pipes to flues. Smaller pipe-ends would stop up with soot in a short time. Soil-pipe gases are gradually absorbed by the porous bricks. If the flue ventilates any room, or if it is a chimney flue, there may be at times down drafts, carrying soil-pipe air into the rooms.

No flue of sheet-metal, earthenware, or brick should be used

Digitized by Google

for ventilation of soil-pipes, waste pipes, drain-pipes, or for trap ventilation.

No soil or waste-pipe in a tenement-house should be used as a leader.

No soil, waste or air-pipe system in a tenement-house should be accepted as completed before its tightness has been tested by the water-pressure, peppermint, smoke test or test by a force-pump and manometer. If the joints do not leak under severe pressure-tests the system of pipes may be considered safe against entrance of sewer-air. (Fig. 30.)

It is a good practice to keep a plan of all drain-pipes, junctions, branches, traps, access-holes, etc., as a guide in case of future examination or repairs.*

Short branch-wastes from the fixtures to the soil, waste, or air-pipes should be of wrought-iron or of lead pipe. Branch-wastes should always be as short and direct as possible, and as little as practicable of the pipe should be hidden under floors. If running under floors, horizontal lead pipes must be continuously supported to prevent sagging.

Connections of lead pipe with cast-iron or wrought-iron pipe-stacks should be made with brass ferrules, connected to the lead pipe with wiped joints and caulked or screwed tightly into the iron pipe.

Joints in lead pipe should always be wiped joints except joints between fixtures and traps, which may be cup joints.

Branch waste-pipes of lead should be of the following sizes:

For a kitchen sink,	1½	inches diameter.
" bath-tub,	1½	"
" basin,	1¼	"
" set of laundry tubs,	1½	"
" slop-siuk,	2	"

*It is not practicable in the climate of our Northern States to locate soil-pipes, as is commonly done in England, outside of the house walls.

It is not necessary to discharge basin, tub, and sink wastes over an open gully or grating in the cellar, as is recommended in English plumbing regulations.

It is also perfectly proper to connect basin, tub, or sink wastes to a soil-pipe, if such is near and convenient. A special waste-pipe is arranged in American plumbing, not for the sake of keeping the tubs or sink-wastes separate from the water-closet wastes, but in order to render the horizontal branch-wastes as short as possible and to avoid cutting of beams.

Digitized by Google

The weight of lead pipe should be *at least:*

2 lbs. for 1¼ inch pipe.
2½ " 1½ "
3 " 2 "

Overflow pipes for fixtures must be as short as possible and should either join the waste-pipe between the fixture and its trap or discharge into the trap below its dip, or else they must be disconnected and discharge over a safe-pan.

Overflow pipes from water-closet cisterns may discharge into the water-closet bowl.

Overflow pipes from drinking water tanks must never have any connection with any drain or soil-pipe. They should discharge into a gutter of the roof or else over an open sink in the basement.

Drip-pipes for "safes" under fixtures should not have any connection whatever with any soil or waste-pipe or the house-sewer. They should be run independently as straight as possible to the basement, where they should discharge over an open sink so that any leakage may be at once discovered.

Refrigerator wastes must never be connected directly to any waste, soil or sewer-pipe. They should empty over an open sink, cup or pan with thoroughly trapped connection to the soil or waste-pipe system, and this connecting pipe should be provided with a stop-cock to shut it off in case the refrigerator is put out of use.

Vertical pipes for the removal of storm-water from roofs (leaders or conductors) must be of cast iron or preferably wrought-iron, if put inside a dwelling, and must have thoroughly tight joints. If located outside they may be of metal (copper, tin or galvanized iron). Upright leaders should not be less than three inches diameter (except for roofs of very small sheds), and their size must be proportioned to the amount of roof-water to be removed.

Rain leaders in tenement-houses should not be used as soil or waste-pipes.

Unless the rain-water is to be collected for storage in cisterns, or unless the rainfall is excluded from the city sewers (separate system of sewerage), it should be discharged into the house-sewer and some of it preferably at its upper ends.

Digitized by Google

Pipes for the removal of storm-water from court-yards and paved areas (yard and area drains) should not be less than two inches in diameter, their size being proportioned to the area to be drained. They should be taken into the cellar by the most direct route, and should join the leader-pipes or the house-sewer.

Subsoil water must be removed by drain-pipes (common tile drains) laid at a sufficient depth below the cellar floor. Tiles of one and one-half or two inches are generally quite sufficient for this purpose. They should be laid with open joints well wrapped with tarred paper or strips of cotton. They are generally run in parallel lines, their distance depending on the character of the ground. Such subsoil drains for tenement-houses in cities must never have a *direct* connection with the house-sewer or any of its branches.

SYSTEM OF TRAPPING.

The main house-sewer for a tenement-house should be trapped before entering the street-sewer or before discharging into a cesspool* (in places having no sewers). No connection with the house-sewer should be made on the street side of the main trap. The old cesspool, or mason's trap, is highly objectionable. The best drain-trap is the inverted siphon or running trap. (Fig. 31.) If located outside the house, it may be of cast-iron or of earthenware. If located inside the house-walls, it should be of cast-iron .

This trap must always be accessible to remove obstructions. If placed outside it may be located in a manhole. The trap must always be placed in a position where it is not exposed to the danger of freezing. It should have cleaning handholes, but the greatest care must be taken, if the trap is placed in the cellar, that the hand-holes are hermetically closed with proper covers.

It is recommended to run into the main trap a front leader, to give it a thorough scouring at each rainfall.

Leader pipes must be trapped only in case the top opens below or near attic windows, or near flues or ventilating shafts, and if the leaders are made of metal with slip-joints, and pass near windows of living or sleeping rooms.

---

*In cases where a city, town, or village constructs an entirely new sewer system, according to a well-devised and uniform plan, it may be possible to dispense with the trap on the main drain, *provided the drainage of all houses is subject to the inspection and carried out according to proper rules of the city authorities.*

Digitized by Google

Iron leaders, with tight joints, the tops of which are remote from windows, flues, ventilating shafts, etc., should not be trapped.

It is preferable *not* to trap leaders, but if a trap is required, it should have a very deep seal, not readily lost by evaporation. The common traps in the market are entirely insufficient for such purpose. Great care must be taken to place the trap out of reach of the frost. It is to be recommended to place the traps for leaders *inside* the cellar walls, and just before the connection with the house-sewer; the trap to be an inverted siphon or S-trap.

Yard and area drains must always be properly trapped. Bell-traps in yard-cesspools (gullies) are entirely insufficient, and highly objectionable. The trap should have a deep seal to provide against evaporation, and must be located out of reach of frost. The same arrangement as for leader-traps is recommended.

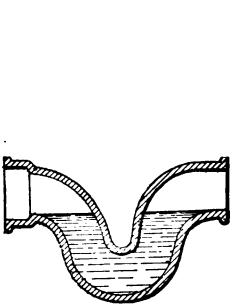


FIG. 31.

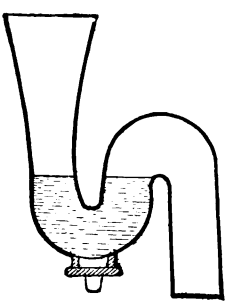


FIG. 32.

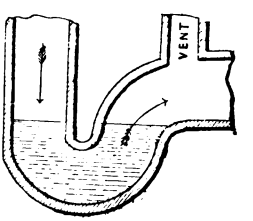


FIG. 33.

Drains to remove sub-soil water must be *thoroughly disconnected* from the main house-sewer, by a trap with very deep seal, or by a gravel trap, or a ball-valve trap.

There must not be a trap at the foot of any soil or waste-pipe stack, nor any other trap between the trap on the main drain and the trap under the fixture, which would all interfere with a proper circulation of air through drain and soil-pipes.

All branch waste-pipes connected to the soil-pipe system must be provided, as near as possible to the outlet of the fixture, with a suitable trap, secure against back pressure, siphonage, evaporation, or absorption of gases.

Overflow-pipes must be connected to the waste-pipe on the inlet side of the trap, or below its water-level, or else they must be disconnected from the waste-pipe system. A separate trapping of an

Digitized by Google

overflow-pipe, connected directly to a soil or waste pipe, is not to be relied upon, as the seal may often be lost by evaporation. The same is true of drip-pipes for "safes", and of refrigerator wastes.

The junction between trap and waste-pipe must be made with great thoroughness, and of great strength, and so as not to be affected by any settlement of the floor.

The junction between the fixture and the trap should preferably be made movable, at least under sinks and tubs, to facilitate repairs of the fixture.

All traps should be placed as close to the fixture as possible.

Traps for water closets should not have a larger depth of seal than 1½ or 2 inches; traps for bowls, sinks, and tubs may with advantage have a larger *dip*.

Traps should be self-cleansing, and free from corners or spaces which favor accumulation of filth.

Traps should hold as little water in volume as possible, so that the contents of the trap may be changed each time a fixture is used.

Traps should never be larger in size than the waste-pipe to which they are attached. It is preferable to have the house-side of the trap funnel-shaped (see Fig. 32), as this increases the scouring action of the flush.

Cleaning-screws or access-holes of traps should be arranged below the water-seal of the trap.

Neither bell-traps nor D-traps must be used anywhere in the drainage system.

Round pipe siphon traps (Figs. 32 and 33)—S, P, and running traps—are the most self-cleansing traps. If used under water-closets, slop-hoppers, wash and bath-tubs they must be protected against siphonage by an air-pipe (Fig. 33), preferably of the full bore of the trap, taken from its sewer-side, and at its crown, and connected to the main vertical air-pipe.

For kitchen sinks or wash-basins, placed vertically above each other, the danger from siphonage is not great; but even here an air-pipe from the crown of the trap may be required, especially if portable wash-tubs are likely to be emptied out into the sinks. A good mechanical trap is preferable to the S-trap, if the vent-pipe is dispensed with.

Where fixtures remain out of use for some length of time, as on unoccupied floors of tenements, it may be better to use one of

Digitized by Google

the better-shaped bottle-traps with deep seal, or mechanical traps, or traps having in addition to water a seal of mercury.

Air-pipes should be attached to all traps—water-seal and mechanical traps—wherever the fixtures are at a distance from the vertical soil or waste-pipe, in order to prevent any long dead ends in the pipe system.

Such air-pipes should be run with a continuous slight pitch either to the trap of the fixture or to the soil-pipe, in order to prevent any collection of water from condensation.

3.—SYSTEM OF FIXTURES.

Plumbing fixtures in tenement-houses should not be scattered, but should be located in vertical groups.

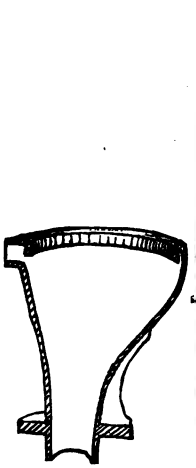


FIG. 34.

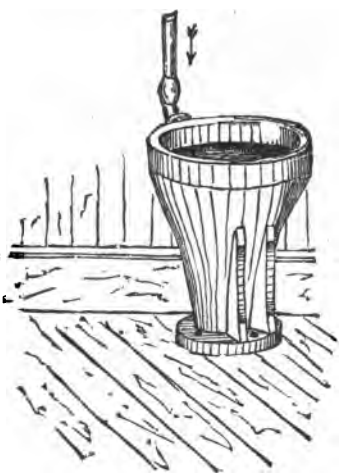


FIG. 35.

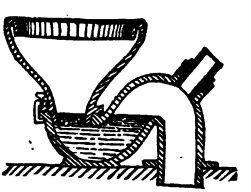


FIG. 36.

The material for such fixtures should be strong and durable, non-absorbent and non-corrosive.

The arrangement of fixtures should be as plain as possible.

There should be little if any wood-work about plumbing fixtures. An open arrangement of sinks and water-closets is to be recommended in the interest of cleanliness.

The outlets of all fixtures, except water-closets, must be protected against obstruction by a fixed strainer.

Each fixture must be separately trapped, as near as possible to its outlet, by a reliable, safe, and self-cleansing trap.

Digitized by Google

There should be an abundant supply of water on each floor of a tenement-house. Wherever the pressure is insufficient to raise the water to the upper floor, a tank at the top floor of the tenement must be provided, sufficient in size to hold one or two days' supply.

FIG. 37.

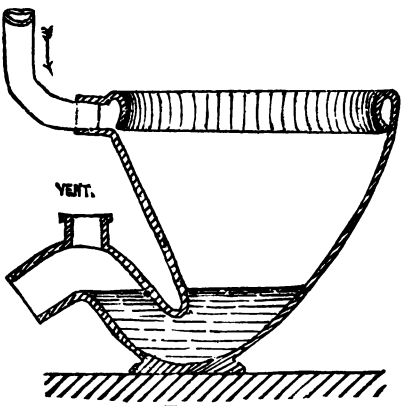


FIG. 38.

If the water does not fill such tank by the pressure in the mains over night, a force-pump should be provided.

Water-tanks for tenement houses must never be lined with lead, galvanized iron, or zinc. Wooden tanks, or iron tanks, well

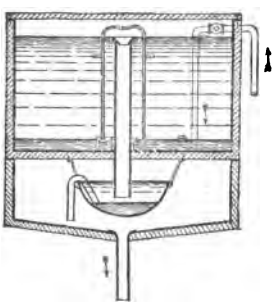


FIG. 39.

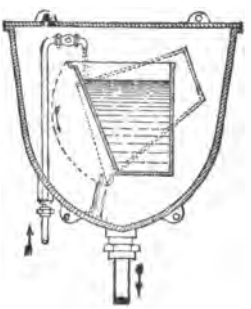


FIG. 40.

painted, or wooden-tanks lined with tinned copper, should be used. The overflow of such tanks should never be connected to any soil, waste, or vent-pipe. A frequent cleaning out of water-tanks is to be recommended, especially where they are used to supply drinking-water. Water-tanks should be covered up and must be well aired.

Digitized by Google

No water-closet, slop-hopper, or kitchen sink should be arranged on tenement floors, unless provision has been made for such adequate and *constant* water-supply.

No water-closet, slop-hopper, sink, or tub should be placed in any apartment or closet of a tenement, not having a window to the outer air, or to a light-and-air-shaft of adequate size.

No water closet, slop-hopper, sink, tub, or bowl should be placed in any living or sleeping room of a tenement-house, nor in the cellar of such building.

No pan-closet should be used in any tenement-house.

Plain hopper-closets (Figs. 34, 35, 36, 37, 38)—preferably short hoppers of improved construction—are recommended in preference to mechanical closets for use in tenement-houses.

The material for such improved hopper-closets should be glass, earthernware, iron lined with glass, or enamelled (porcelain-lined) iron. Hopper-closets of glass probably approach the ideal closet more than any other kind, but they are not yet manufactured. Closets of best earthenware answer all practical requirements. Enamelled iron closets are to be preferred only on account of their strength where a very rough and careless use of the closets may be expected.

Each water-closet in a tenement-house must be flushed from a special cistern, located in the apartment at a sufficient height over the closet-bowl to insure a strong flush. This cistern must never be used to draw water for drinking or cooking purposes

The down pipe from the cistern to the closet-bowl must not be less than $1\frac{1}{4}$ inches diameter.

Water-closet cisterns in tenements should be operated by chain and pull-down handle, or else by seat action. The latter arrangement is preferable for careless tenants and children. Automatic flushing tanks, siphon tanks (Fig. 39), and tilting tanks (Fig. 40), discharging at frequent fixed intervals during the day, and placed under exclusive control of a janitor, are to be recommended for tenements.

Slop-hoppers must be flushed from special cisterns, preferably automatic flushing-tanks, in the same manner as water-closets. They must have strong metallic strainers to prevent improperly-thrown substances from choking the pipes.

Water-closets and slop-hoppers in tenements should always be

Digitized by Google

arranged in an open manner, and tight boxing-up apparatus should not be permitted.

The floor must be made impervious, and slate slabs are recommended for this purpose. The closet should stand free on top of such slate slab, accessible on all sides for inspection and cleaning purposes. The seat should be a plain, well-finished hard-wood board, with proper hole, and hinged at the back or one end, so as to be readily lifted, when the closet is not in use. Such open arrangement facilitates the use of the closet by men or boys as a urinal. A further improvement is to raise the closet a step, but to leave a part of the floor, wide enough to allow a person to stand between the steps on each side in front of the closet, at the common level of the room. This arrangement raises the closet-bowl to about the height of a urinal basin, and prevents spilling if the water-closet is used as a urinal.

It is much to be recommended to arrange a laundry on the top floor of a tenement-house, to be used alternately by the tenants, and kept under the control of a janitor.

A simple bath-tub for each tenement (at least of the better class) is very desirable on the score of cleanliness and health. If arranged in the kitchen, it is easy to provide even a warm bath by pouring pails of hot water from the range into the tub. It is perfectly feasible to construct such bath-tubs so as to serve also as laundry tubs.

THE CASE, LOCKWOOD & BRAINARD CO., PRINTERS, HARTFORD, CONN.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google